

【特許請求の範囲】

【請求項1】 炭化水素系原燃料ガスを水蒸気改質して得られた燃料ガスと酸化剤ガスとしての空気との電気化学反応に基づいて電気を発生する燃料電池と、燃料改質系機器と、燃料電池の冷却水系機器と、燃料電池の排空
 気および燃料改質器の燃焼排ガス中の水を回収する回収水系機器とを有する燃料電池発電装置において、
 前記回収水系機器は、回収水タンクと、この回収水タンク内上部に設けた散水装置と、回収水冷却器と、回収水
 タンク内の液面を検出する液面計と、この液面計の液位計測結果に基づき精製水を補給する精製水補給容器とを
 備えたことを特徴とする燃料電池発電装置。

【請求項2】 請求項1に記載の燃料電池発電装置において、前記回収水タンクは、回収水タンク内上部における散水装置と排空気導入口および燃焼排ガス導入口との間に、冷却水直接触式凝縮器としてのラシヒリング等の充填層を備えことを特徴とする燃料電池発電装置。

【請求項3】 請求項1または2に記載の燃料電池発電装置において、前記回収水タンクは、過剰な回収水を排出するためのオーバーフロー管を備えたことを特徴とする燃料電池発電装置。

【請求項4】 請求項1ないし3のいずれかに記載の燃料電池発電装置の運転方法であって、前記液面計の液位計測結果が所定レベル(L)より高位を示す定常運転時には、精製水を補給することなく回収水による水自立運転を行ない、前記液位計測結果が所定レベル(L)に到達した際には、精製水補給容器から精製水を所定レベル(H)まで補給して運転を継続することを特徴とする燃料電池発電装置の運転方法。

【請求項5】 請求項4に記載の運転方法において、何らかの原因で前記水自立運転が不可能となって、前記液面計の液位計測結果が所定の最下限レベル(LL)に到達した際には、精製水の補給を停止し、かつ燃料電池発電装置の運転を停止することを特徴とする燃料電池発電装置の運転方法。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】この発明は、炭化水素系原燃料を水蒸気改質して得られた燃料ガスと酸化剤ガス(空気)との電気化学反応に基づいて電気を発生する燃料電池と、燃料改質系機器と、燃料電池の冷却水系機器と、燃料電池の排空気および燃料改質器の燃焼排ガス中の水を回収する回収水系機器とを有する燃料電池発電装置とその運転方法に関する。

【0002】

【従来の技術】燃料電池発電装置に組み込まれる燃料電池としては、電解質の種類、改質原料の種類等によって異なる種々のタイプがあるが、例えば、固体高分子膜を電解質として用い、その運転温度が約80℃と比較的低いタイプの燃料電池として、固体高分子電解質型燃料電

池がよく知られている。

【0003】この固体高分子電解質型燃料電池は、リン酸型燃料電池と同様に、例えばメタンガス(都市ガス)等の炭化水素系原燃料を水蒸気改質して得られた燃料ガス中の水素と空気中の酸素とを、燃料電池の燃料極および空気極にそれぞれ供給し、電気化学反応に基づいて発電を行うものである。

【0004】また、原燃料を燃料ガスへ改質するに際しては、原燃料に水蒸気を加え燃料改質器で触媒により改質を促進する方法が採られているが、改質を定常に行なうには所要の水蒸気量を定常的に補給する必要がある、水蒸気の供給装置には、これに対応した水を常時補給する必要がある。なお、使用する水は高純度の水であることが必要であり、イオン交換式の水処理装置で不純物を除去したイオン交換水が用いられるのが通例である。

【0005】一方、燃料電池の電気化学反応では発電生成水が生じ、また燃料改質器では吸熱反応である水蒸気改質反応を定常に行なうための触媒加熱用の燃焼に伴い燃焼生成水が生じるが、これらの生成水は通常の水道水に比べて不純物が少なく、これらの生成水を原水として用いれば、水処理装置の負荷を軽減することができるため、回収水タンクおよび排ガス冷却器を付加して、これらの生成水を回収して改質水蒸気発生用の供給水とする方法が、通常採用されている。

【0006】また、燃料電池の電気化学反応では反応に伴って熱が発生し、この排熱エネルギーの一部は、貯湯槽に温水として貯え、給湯もしくは暖房に供される。

【0007】図2は、都市ガスを原燃料とする従来の固体高分子電解質型燃料電池発電装置の一例を示す系統図である。

【0008】図2において、模式的に示した燃料電池10は、燃料極10aと空気極10bとを有する単位セルを複数個重ねる毎に冷却管または冷却溝を有する図示しない冷却板を配設、積層することにより構成されている。

【0009】原燃料はまず改質用水蒸気とともに改質器11に供給され、以下の反応により、水素と一酸化炭素に改質される。改質用の触媒としては、貴金属系触媒またはニッケル系触媒が用いられる。

【0010】 $\text{CH}_4 + \text{H}_2\text{O} \rightarrow 3\text{H}_2 + \text{CO}$ (吸熱反応)

その後、この改質ガスは、CO変成器12に供給され、以下の反応により、改質ガス中の一酸化炭素は1%程度まで低減される。CO変成用触媒としては、貴金属系触媒または銅-亜鉛系触媒が用いられる。

【0011】 $\text{CO} + \text{H}_2\text{O} \rightarrow \text{H}_2 + \text{CO}_2$ (発熱反応)

その後、さらにCO除去器13に供給され、ブローによって供給された空気によりCOを選択酸化する以下の反応により、改質ガス中の一酸化炭素は10ppm程度まで低減された後、燃料電池の燃料極10aに供給される。

【0012】 $\text{CO} + 1/2\text{O}_2 \rightarrow \text{CO}_2$ (発熱反応)

上記の如く、改質器11において改質反応を行う場合、水蒸気を供給する必要がある、固体高分子型燃料電池発電装置では、その熱源として改質器11の燃焼排ガスの顕熱、CO変成器12及びCO除去器13の反応熱を利用するのが一般的である。そのため、ポンプ54にて供給される改質用水を、CO変成器12、CO除去器13、水蒸気発生器14の各反応器を直列に順次流すための改質用水蒸気供給ライン15を設け、前記各反応器から熱を受けて水蒸気とし、この水蒸気と原燃料とを混合して、改質用水蒸気供給ライン15から改質器11へ導

入する構成としている。なお、図2においては、CO変成器12、CO除去器13への前記改質用水の通流ラインを省略している。

【0013】又、上記の各反応器は触媒による化学反応を行うため、燃料電池発電装置の起動時には、適正な温度に予め昇温する必要がある。各反応器の適正な温度は以下のとおりである。改質器：500～700℃、CO変成器：200～300℃、CO除去器：100～250℃である。

【0014】このため、改質器11は、燃料電池の排水素供給ライン19から供給される水素を改質器内に設置されているバーナで燃焼させることで、通常時は加熱されているが、起動時には原燃料をバーナで燃焼させることにより昇温している。また、改質器の燃焼排ガスにより水蒸気発生器14も昇温している。一方、CO変成器12とCO除去器13とは、それぞれが個々に備える図示しない電気ヒータにより昇温している。前記バーナには、燃焼空気ブロア18により、燃焼用空気が導入される。なお、18aは、燃料電池本体の空気極に反応用の空気およびCO除去器におけるCO選択酸化用の空気を供給するための反応空気ブロアである。

【0015】また、都市ガスは、都市ガス昇圧ブロア17により、まず脱硫器16へ導入され、都市ガス内に含まれる硫黄成分が除去された後、改質器11の触媒反応器へ導入され、前記燃焼排ガスにより熱の供給を受けながら改質され、水素リッチな燃料ガスとなる。

【0016】次に、図2における燃料電池の冷却水系機器50および回収水系機器30について以下に述べる。冷却水系機器50は、電池冷却水冷却器51と、カソードオフガス冷却器52と、燃焼排ガスの排ガス冷却器53と、純水タンク55と、電池冷却水循環ポンプ54、その他配管等を含む。

【0017】燃料電池10は、前述のように約80℃で運転され、前記電池冷却水循環ポンプ54によって、純水タンク55から通流される水によって冷却され、電池冷却水冷却器51によって除熱される。電池冷却水冷却器51には、図2には図示しない貯湯槽に接続される循環水導出ライン56から供給される、例えば約50℃の水が導入され、ここで電池冷却水を冷却した水は、その後、カソードオフガス冷却器52および燃焼排ガスの排

ガス冷却器53を経由して、例えば約60℃に昇温されて、循環水導出ライン57から前記貯湯槽に還流する。前記純水タンク55には、液面計が設けてあり、液面が下限に到達した際には、後述する回収水が、水処理装置35を介して、間歇的に補給される。

【0018】次に、回収水系機器30について述べる。回収水系機器30は、回収水タンク31と、回収水ポンプ33と、回収水冷却器34等からなる。前記回収水タンク31の上部には、カソードオフガス冷却器52および燃焼排ガスの排ガス冷却器53により冷却されたオフ空気および燃焼排ガスが導入され、空気およびガス中の含有水分を、上部に設けた散水装置から冷却水を散布することにより凝縮して、回収水タンク31の下部に回収する。この回収水を、回収水冷却器34により冷却して、前記散水装置に導入する。この散水装置の後段には、ラシヒリング等の充填層を備えた冷却水直接触式凝縮器を設ける場合もある。

【0019】この場合、水蒸気を含むオフ空気と燃焼排ガスを、図2には図示しない充填層下部から上方に通流し、一方、上部から回収水冷却器34で冷却された40℃程度の回収水を散水して、充填層部分でガスと冷却水を直接触させながら、空気およびガス中の水蒸気分を凝縮・回収するものであり、簡単な構造で、回収効率が高くなる利点がある。

【0020】上記回収水は、前述のように、水処理装置で純化され補給水として用いられる。なお、回収水タンク31の下部にも液面計が設けられ、回収水タンク内の水が不足した場合には、補給水として市水(水道水)が供給され、この市水は水処理装置で純化される。

【0021】

【発明が解決しようとする課題】ところで、前述のように補給水として市水を用い水処理装置で純化を行なう従来の燃料電池発電装置においては、下記のような問題点があった。

【0022】前記水処理装置は、イオン交換樹脂の寿命が短く、イオン交換樹脂の交換作業を含めたメンテナンス費用が高い。この費用の燃料電池発電装置のランニングコストを含めた全コストに占める割合が大きいため、燃料電池発電装置の採否に当たって、経済性の観点におけるネックの一つとなっている。

【0023】また、前記水処理装置は、燃料電池の運転中においても系内から熱の供給がないので、寒冷地においては、凍結の恐れがあり、凍結防止対策も、全体コストを増大する一つの要因ともなっている。

【0024】本来、燃料電池の電気化学反応では発電生成水が生じ、また燃料改質器においても燃焼に伴い燃焼生成水が生じ、前述のように、これらの生成水を回収して改質水蒸気発生用の供給水とすれば、必要な供給水に比較して回収水の方が勝り、通常、回収水を回収水タンクからオーバーフローさせている。さらに、前記回収水

は通常の水道水に比べて不純物が少ない上、固体高分子型燃料電池は、リン酸型燃料電池のように回収水中にリン酸が存在しないので、水処理装置がなくとも、自立運転が可能なのはである。

【0025】ところが、例えば夏季において、外気温が35℃以上となった場合には、回収水冷却器34の性能が低下し、空気およびガス中の水蒸気が凝縮できず、直接接触式熱交換器の性能が低下して回収水が不足する事態が生ずる。また、外気温が35℃以下であっても、長時間運転において、前述のラシヒリング等の充填層にスライム等が付着したり、また、散水装置のノズルが水垢等により詰まったような場合においても、直接接触式熱交換器の性能が低下して回収水が不足する事態が生ずる。この場合には、純度の低い市水を補給することになるので、水処理装置は不可欠である。

【0026】この発明は、上記問題点を鑑みてなされたもので、この発明の課題は、常時は回収水による水自立運転を可能とし、自立運転が不可能な短時間特殊ケースにおいても、水処理装置なしに純度の高い水の補給を行なうことが可能にしてかつ安価な燃料電池発電装置とその運転方法を提供することにある。

【0027】

【課題を解決するための手段】前述の課題を解決するために、この発明においては、炭化水素系原燃料ガスを水蒸気改質して得られた燃料ガスと酸化剤ガスとしての空気との電気化学反応に基づいて電気を発生する燃料電池と、燃料改質系機器と、燃料電池の冷却水系機器と、燃料電池の排空気および燃料改質器の燃焼排ガス中の水を回収する回収水系機器とを有する燃料電池発電装置において、前記回収水系機器は、回収水タンクと、この回収水タンク内上部に設けた散水装置と、回収水冷却器と、回収水タンク内の液面を検出する液面計と、この液面計の液位計測結果に基づき精製水を補給する精製水補給容器とを備えたものとする（請求項1の発明）。

【0028】上記請求項1の発明によれば、後述するように、定常運転時には、精製水を補給することなく回収水による水自立運転を行ない、液位計測結果により、水自立運転の不可能の事態が判明した際には、精製水補給容器から精製水を補給して運転を継続することができ、精製水補給容器としては、薬局等で市販されている安価な精製水ボトル（例えば、350mlのボトルで98円）が利用できる。また、精製水補給用タンクに、購入した精製水を貯水することもできる。

【0029】前記請求項1の発明の実施態様としては、下記請求項2ないし3の発明が好ましい。また、運転方法としては、下記請求項4ないし5の発明が好ましい。上記請求項2ないし5の発明の作用効果については、前記従来の技術の項等の記載において、大略説明したとおりである。なお、細部については、後述する実施例において補足して説明する。

【0030】即ち、前記請求項1に記載の燃料電池発電装置において、前記回収水タンクは、回収水タンク内上部における散水装置と排空気導入口および燃焼排ガス導入口との間に、冷却水直接接触式凝縮器としてのラシヒリング等の充填層を備えたものとする（請求項2の発明）。

【0031】また、前記請求項1または2に記載の燃料電池発電装置において、前記回収水タンクは、過剰な回収水を排出するためのオーバーフロー管を備えたものとする（請求項3の発明）。

【0032】さらに、前記請求項1ないし3のいずれかに記載の燃料電池発電装置の運転方法であって、前記液面計の液位計測結果が所定レベル（L）より高位を示す定常運転時には、精製水を補給することなく回収水による水自立運転を行ない、前記液位計測結果が所定レベル（L）に到達した際には、精製水補給容器から精製水を所定レベル（H）まで補給して運転を継続する（請求項4の発明）。

【0033】さらにまた、前記請求項4に記載の運転方法において、何らかの原因で前記水自立運転が不可能となって、前記液面計の液位計測結果が所定の最下限レベル（LL）に到達した際には、精製水の補給を停止し、かつ燃料電池発電装置の運転を停止する（請求項5の発明）。

【0034】

【発明の実施の形態】図面に基づき、本発明の実施例について以下にのべる。

【0035】図1は、この発明に関わる実施例を示す系統図であり、図2と同じ機能を有する部材には同一の番号を付して説明を省略する。また、図1においては、説明の便宜上、図2に示したシステム系統の内、回収水系機器30を主体として、一部追加変更して示し、燃料電池、燃料改質系機器、電池冷却水系等の他の系統は省略して示す。

【0036】図1と図2との相違点は、図1における回収水タンク31は、散水装置32と排空気導入口および燃焼排ガス導入口との間に設けた充填層36と、液面計37と、精製水ボトル38と、この液面計の液位計測結果に基づき精製水の補給制御を行うための開閉制御弁39と、過剰な回収水を排出するためのオーバーフロー管40とを備える点である。

【0037】前記液面計37は、図1に示すH、L、LLの3段階の液位を、図示しない制御装置に出力して、後述する精製水の補給や装置の停止等の制御を行うように構成されている。即ち、前述のように、液面計37の液位計測結果により、所定レベル（L）より高位を示す定常運転時には、開閉制御弁39は閉とし、精製水を補給することなく回収水による水自立運転を行なう。また、前記液位計測結果が所定レベル（L）に到達した際には、開閉制御弁39を開とし、精製水ボトル38から

精製水を所定レベル（H）まで補給して運転を継続する。

【0038】さらに、何らかの原因で前記水自立運転が不可能となって、液面計37の液位計測結果が所定の最下限レベル（LL）に到達した際には、開閉制御弁39は閉として精製水の補給を停止し、かつ燃料電池発電装置の運転を停止する。

【0039】ところで、回収水による水自立運転を長期間継続した場合に、水処理装置におけるイオン交換樹脂により、系内の水が純化されないので、系内の水の電気伝導率が徐々に増大することが考えられる。この点に関し、実施例に関して追跡調査したところ、約48時間経過後は、飽和状態（約 $10\mu\text{S}/\text{cm}$ 以内で飽和）に達することが判明した。従って、例えば4万時間の運転後（約5年に一度）系内の水を純水で置換する等の対処により、回収水による水自立運転は、問題なく長期間継続できる。

【0040】

【発明の効果】上記のとおり、この発明によれば、炭化水素系原燃料ガスを水蒸気改質して得られた燃料ガスと酸化剤ガスとしての空気との電気化学反応に基づいて電気を発生する燃料電池と、燃料改質系機器と、燃料電池*

*の冷却水系機器と、燃料電池の排空気および燃料改質器の燃焼排ガス中の水を回収する回収水系機器とを有する燃料電池発電装置において、前記回収水系機器は、回収水タンクと、この回収水タンク内上部に設けた散水装置と、回収水冷却器と、回収水タンク内の液面を検出する液面計と、この液面計の液位計測結果に基づき精製水を補給する精製水補給容器とを備えるものとしたので、常時は回収水による水自立運転を可能とし、自立運転が不可能な短時間特殊ケースにおいても、水処理装置なしに純度の高い水の補給を行なうことが可能にしてかつ安価な燃料電池発電装置とその運転方法を提供することができる。

【図面の簡単な説明】

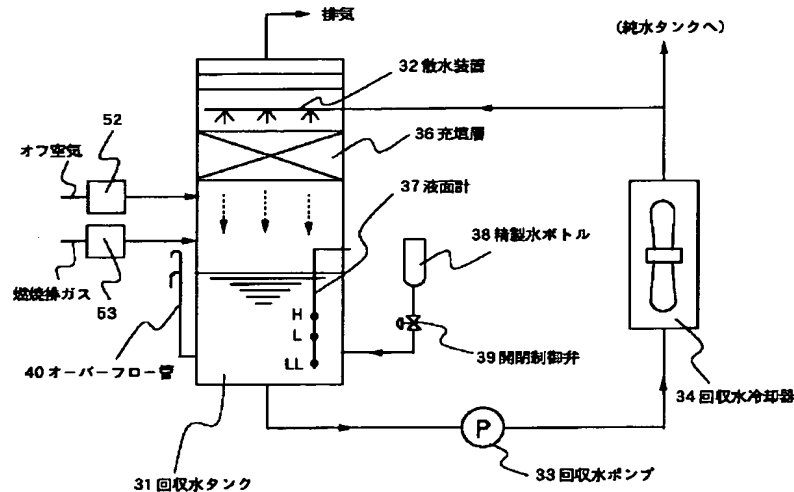
【図1】この発明の燃料電池発電装置の実施例に関わる主に回収水系機器の系統図

【図2】従来の燃料電池発電装置の一例を示す系統図

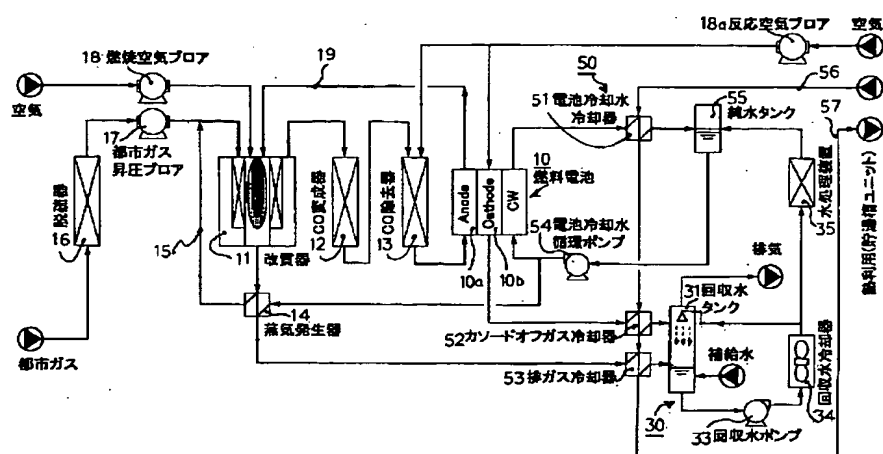
【符号の説明】

10：燃料電池、20：改質系機器、30：回収水系機器、31：回収水タンク、32：散水装置、33：回収水ポンプ、34：回収水冷却器、36：充填層、37：液面計、38：精製水ボトル、39：開閉制御弁、40：オーバーフロー管、50：冷却水系機器。

【図1】



【図2】



【公報種別】特許法第17条の2の規定による補正の掲載
 【部門区分】第7部門第1区分
 【発行日】平成17年7月7日(2005.7.7)

【公開番号】特開2003-288936(P2003-288936A)
 【公開日】平成15年10月10日(2003.10.10)
 【出願番号】特願2002-91424(P2002-91424)
 【国際特許分類第7版】

H 0 1 M 8/06
 H 0 1 M 8/04
 H 0 1 M 8/10

【F I】

H 0 1 M 8/06 W
 H 0 1 M 8/04 N
 H 0 1 M 8/04 Y
 H 0 1 M 8/10

【手続補正書】
 【提出日】平成16年11月4日(2004.11.4)
 【手続補正1】
 【補正対象書類名】明細書
 【補正対象項目名】特許請求の範囲
 【補正方法】変更
 【補正の内容】
 【特許請求の範囲】
 【請求項1】

炭化水素系原燃料ガスを水蒸気改質して得られた燃料ガスと酸化剤ガスとしての空気との電気化学反応に基づいて電気を発生する燃料電池と、燃料改質系機器と、燃料電池の冷却水系機器と、燃料電池の排空気および燃料改質器の燃焼排ガス中の水を回収する回収水系機器とを有する燃料電池発電装置において、

前記回収水系機器は、回収水タンクと、この回収水タンク内上部に設けた散水装置と、回収水冷却器と、回収水タンク内の液面を検出する液面計と、この液面計の液位計測結果に基づき精製水を補給する精製水補給容器とを備えたことを特徴とする燃料電池発電装置。

【請求項2】

請求項1に記載の燃料電池発電装置において、前記回収水タンクは、回収水タンク内上部における散水装置と排空気導入口および燃焼排ガス導入口との間に、冷却水直接接触式凝縮器としてのラシヒリング等の充填層を備えたことを特徴とする燃料電池発電装置。

【請求項3】

請求項1または2に記載の燃料電池発電装置において、前記回収水タンクは、過剰な回収水を排出するためのオーバーフロー管を備えたことを特徴とする燃料電池発電装置。

【請求項4】

請求項1ないし3のいずれかに記載の燃料電池発電装置の運転方法であって、前記液面計の液位計測結果が所定レベル(L)より高位を示す定常運転時には、精製水を補給することなく回収水による水自立運転を行ない、前記液位計測結果が所定レベル(L)に到達した際には、精製水補給容器から精製水を所定レベル(H)まで補給して運転を継続することを特徴とする燃料電池発電装置の運転方法。

【請求項5】

請求項4に記載の運転方法において、何らかの原因で前記水自立運転が不可能となって、前記液面計の液位計測結果が所定の最下限レベル(LL)に到達した際には、精製水の

補給を停止し、かつ燃料電池発電装置の運転を停止することを特徴とする燃料電池発電装置の運転方法。

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-288936

(43)Date of publication of application : 10.10.2003

(51)Int.Cl.

H01M 8/06

H01M 8/04

H01M 8/10

(21)Application number : 2002-091424 (71)Applicant : FUJI ELECTRIC CO LTD

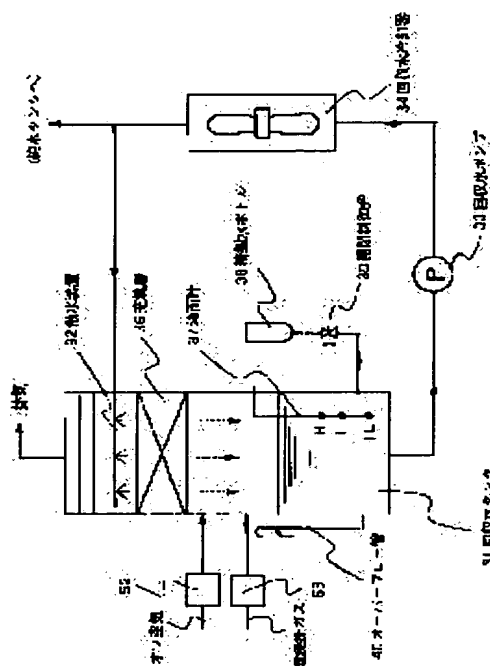
(22)Date of filing : 28.03.2002 (72)Inventor : SENDA MASAHIITO

(54) FUEL CELL POWER GENERATING SYSTEM AND ITS OPERATION METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an inexpensive fuel cell power generating system and its operation method, capable of normally conducting water self sustaining with recovered water, and replenishing high purity water without using a water treatment device even in a special case where the self sustaining is impossible for a short time.

SOLUTION: This fuel cell power generating system is equipped with a fuel cell 10 generating electricity based on electrochemical reaction of fuel obtained by steam-reformed hydrocarbon-based fuel gas with air acting as oxidizing agent gas, a fuel reforming apparatus 20; a cooling water apparatus 50, a water recovering apparatus 30 recovering water in exhaust air of the fuel cell and combustion gas of a fuel reformer. The water recovering apparatus is equipped with a recovered water tank 31, a sprinkling device installed in the upper part inside the recovered water tank, a recovered water cooler 34, a level gauge 37 detecting a liquid level inside the recovered water tank, and a purified water bottle 38 replenishing purified water according to a liquid level measured result of the level gauge.



LEGAL STATUS

[Date of request for examination] 04.11.2004

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's
decision of rejection]

[Date of requesting appeal against
examiner's decision of rejection]

[Date of extinction of right]

Copyright (C); 1998,2003 Japan Patent Office

* NOTICES *

JPO and NCIP are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The fuel cell which generates the electrical and electric equipment based on electrochemical reaction with the air as the fuel gas obtained by carrying out steam reforming of the hydrocarbon system Hara fuel gas, and oxidizer gas, In the fuel cell power plant which has a fuel reforming system device, the cooling-water-system device of a fuel cell, and the recycled water system device that collects the water in the exhaust of a fuel cell, and the combustion gas of a fuel reforming machine Said recycled water system device is a fuel cell power plant characterized by having a recycled water tank, the sprinkler system prepared in the upper part in this recycled water tank, a recycled water condensator, the level gage which detects the oil level in a recycled water tank, and the purified water supply container which supplies purified water based on the liquid level measurement result of this level gage.

[Claim 2] It is the fuel cell power plant characterized for packed beds, such as Raschig ring as a cooling water direct contact process condenser, by things in preparation for between sprinkler systems, exhaust inlets, and combustion-gas inlets. [in / on a fuel cell power plant according to claim 1 and / in said recycled water tank / the upper part in a recycled water tank]

[Claim 3] It is the fuel cell power plant characterized by having an overflow pipe for said recycled water tank discharging superfluous recycled water in a fuel cell power plant according to claim 1 or 2.

[Claim 4] The operating method of the fuel cell power plant characterized by supplying purified water from a purified water supply container to predetermined level (H), and continuing operation at the time of steady operation whose liquid level measurement result of said level gage are the operating method of a fuel cell power plant according to claim 1 to 3, and shows a high order from predetermined level (L) when water self-sustaining by recycled water is performed and said liquid level measurement result reaches predetermined level (L), without supplying purified water.

[Claim 5] The operating method of the fuel cell power plant characterized by stopping supply of purified water and suspending operation of a fuel cell power plant when said water self-sustaining becomes impossible by a certain cause and the liquid level measurement result of said level gage reaches the predetermined maximum minimum level (LL) in an operating method according to claim 4.

[Translation done.]

* NOTICES *

JPO and NCIPi are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the fuel cell power plant which has the fuel cell which generates the electrical and electric equipment based on the electrochemical reaction of the fuel gas and oxidizer gas (air) which were obtained by carrying out steam reforming of the hydrocarbon system Hara fuel, a fuel reforming system device, the cooling-water-system device of a fuel cell, and the recycled water system device that collects the water in the exhaust of a fuel cell, and the combustion gas of a fuel reforming machine, and its operating method.

[0002]

[Description of the Prior Art] Although there are various types which change with an electrolytic class, classes of reforming raw material, etc. as a fuel cell built into a fuel cell power plant, the solid-state polyelectrolyte mold fuel cell is well known as a type fuel cell with the operating temperature comparatively as low as about 80 degrees C, for example, using a solid-state poly membrane as an electrolyte.

[0003] This solid-state polyelectrolyte mold fuel cell supplies the hydrogen in the fuel gas obtained by carrying out steam reforming of the hydrocarbon system Hara fuels, such as methane (town gas), and the oxygen in air to the fuel electrode and air pole of a fuel cell like a phosphoric acid fuel cell, respectively, and generates electricity based on electrochemical reaction.

[0004] Moreover, although the approach of facing reforming a original fuel to fuel gas, adding a steam to a original fuel, and promoting reforming according to a catalyst with a fuel reforming vessel is taken, it is necessary to supply a necessary water vapor content regularly for performing reforming regularly, and to always supply the water corresponding to this to the feeder of a steam. In addition, the water to be used needs to be water of a high grade, and it is usually that the ion exchange water from which the impurity was removed by the water treating unit of an ion-exchange type is used.

[0005] On the other hand, although generation-of-electrical-energy generation water arises and combustion generation water arises with the combustion for catalyst heating for performing regularly the steam-reforming reaction which is endothermic reaction with a fuel reforming vessel according to the electrochemical reaction of a fuel cell If these generation water has few impurities compared with the usual tap water and these generation water is used as raw water, since the load of a water treating unit is mitigable, A recycled water tank and an exhaust gas condensator are added, and the approach of collecting these generation water and making it into the feedwater for reforming steam generating is usually adopted.

[0006] Moreover, in the electrochemical reaction of a fuel cell, heat occurs with a

reaction, a part of this exhaust heat energy is stored in a storage tank as warm water, and hot-water supply or heating is presented with it.

[0007] Drawing 2 is the schematic diagram showing an example of the conventional solid-state polyelectrolyte mold fuel cell power plant which uses town gas as a original fuel.

[0008] In drawing 2, the fuel cell 10 shown typically is constituted arrangement and by carrying out a laminating in the cooling plate which has a cooling pipe or a cooling slot and which is not illustrated, whenever it piles up two or more unit cells which have fuel electrode 10a and air pole 10b.

[0009] a original fuel -- first -- reforming -- service water -- the reforming machine 11 is supplied with a steam and reforming is carried out to hydrogen and a carbon monoxide by the following reactions. As a catalyst for reforming, a noble-metals system catalyst or a nickel system catalyst is used.

[0010] $\text{CH}_4 + \text{H}_2\text{O} \rightarrow 3\text{H}_2 + \text{CO}$ (endothermic reaction)

Then, this reformed gas is supplied to the CO transformer 12, and - carbon monoxide in reformed gas is reduced to about 1% by the following reactions. As a catalyst for CO conversion, a noble-metals system catalyst or a copper-zinc system catalyst is used.

[0011] $\text{CO} + \text{H}_2\text{O} \rightarrow \text{H}_2 + \text{CO}_2$ (exothermic reaction)

Then, after the carbon monoxide in reformed gas is reduced to about 10 ppm, it is supplied to fuel electrode 10a of a fuel cell by the reaction of the following which carries out selective oxidation of CO with the air which was further supplied to CO removal machine 13, and was supplied by Blois.

[0012] $\text{CO} + \frac{1}{2}\text{O}_2 \rightarrow \text{CO}_2$ (exothermic reaction)

When performing a reforming reaction in the reforming machine 11 like the above, it is common for it to be necessary to supply a steam and to use the heat of reaction of the sensible heat of the combustion gas of the reforming machine 11, the CO transformer 12, and CO removal machine 13 as the heat source in a solid-state macromolecule mold fuel cell power plant. therefore, reforming supplied with a pump 54 -- reforming for pouring each reactor of the CO transformer 12, CO removal machine 13, and the steam generator 14 for service water one by one to a serial -- service water -- the steamy supply line 15 -- preparing -- said each reactor to heat -- winning popularity -- a steam -- carrying out -- this steam and a original fuel -- mixing -- reforming -- service water -- it is considering as the configuration introduced from the steamy supply line 15 to the reforming machine 11. in addition, drawing 2 -- setting -- said reforming to the CO transformer 12 and CO removal machine 13 -- conduction Rhine of service water is omitted.

[0013] Moreover, in order for each above-mentioned reactor to perform the chemical reaction by the catalyst, it is necessary to carry out the temperature up of it to proper temperature beforehand at the time of starting of a fuel cell power plant. The proper temperature of each reactor is as follows. Reforming machine: They are 500-700 degrees C, CO transformer: 200-300 degree C, and CO removal machine: 100-250-degree C.

[0014] For this reason, although it is burning the hydrogen supplied from the exhausted hydrogen supply line 19 of a fuel cell by the burner currently installed in the reforming machine and is usually heated at the time, the temperature up of the reforming machine 11 is carried out by burning a original fuel by the burner at the time of starting. Moreover, the temperature up also of the steam generator 14 is carried out with the combustion gas of a reforming machine. On the other hand, each is carrying out the temperature up of the CO transformer 12 and the CO removal machine 13 by the electric heater which it has separately and which is not illustrated. A combustion air is introduced into said burner by the combustion air blower 18. In addition, 18a is a reaction air blower for supplying the air for a reaction, and the air for CO selective oxidation in CO removal

machine to the air pole of the body of a fuel cell.

[0015] moreover, while it is introduced first to a desulfurizer 16, it is introduced by it to the catalytic-reaction machine of the reforming machine 11 after the sulfur component contained in town gas is removed by town gas pressure-up Blois 17, and said combustion gas receives supply of heat, reforming of the town gas is carried out -- having -- hydrogen -- it becomes rich fuel gas.

[0016] Next, the cooling-water-system device 50 and the recycled water system device 30 of a fuel cell in drawing 2 are described below. The cooling-water-system device 50 contains the cell cooling water cooler 51, the cathode off-gas condensator 52, the exhaust gas condensator 53 of a combustion gas, a demineralised water tank 55, a cell cooling water circulation pump 54, its outcrossing tubing, etc.

[0017] It is operated at about 80 degrees C as mentioned above, and is cooled with the water by which conduction is carried out from a demineralised water tank 55 with said cell cooling water circulation pump 54, and a fuel cell 10 is cooled by the cell cooling water cooler 51. After that, via the cathode off-gas condensator 52 and the exhaust gas condensator 53 of a combustion gas, the temperature up of the water which about 50-degree C water was introduced and cooled cell cooling water in the cell cooling water cooler 51 here for example, drawing 2 was supplied from circulating water derivation Rhine 56 connected to the storage tank which is not illustrated is carried out to about 60 degrees C, and it flows back from circulating water derivation Rhine 57 to said storage tank. The level gage is established, and when an oil level reaches a minimum, the recycled water mentioned later is intermittently supplied to said demineralised water tank 55 through a water treating unit 35.

[0018] Next, the recycled water system device 30 is described. The recycled water system device 30 serves as the recycled water tank 31 and the recycled water pump 33 from recycled water condensator 34 grade. The off air and the combustion gas which were cooled by the cathode off-gas condensator 52 and the exhaust gas condensator 53 of a combustion gas are introduced into the upper part of said recycled water tank 31, and it condenses by sprinkling cooling water from the sprinkler system which prepared the content moisture in air and gas in the upper part, and collects in the lower part of the recycled water tank 31. It cools with the recycled water condensator 34, and this recycled water is introduced into said sprinkler system. The cooling water direct contact process condenser equipped with packed beds, such as Raschig ring, may be formed in the latter part of this sprinkler system.

[0019] in this case, carry out conduction of the OFF air containing a steam, and the combustion gas to the upper part from the packed bed lower part which be illustrate to drawing 2 , sprinkle the about 40 - degree C recycled water cooled with the recycled water condensator 34 from the upper part on the other hand, and contact gas and cooling water directly in a packed bed part, parts for the steam in air and gas be condense and collect, and there be an advantage whose recovery effectiveness improve with easy structure.

[0020] As mentioned above, it is purified by the water treating unit and the above-mentioned recycled water is used as make up water. In addition, when a level gage is prepared also in the lower part of the recycled water tank 31 and the water in a recycled water tank runs short, a city water (tap water) is supplied as make up water, and this city water is purified by the water treating unit.

[0021]

[Problem(s) to be Solved by the Invention] By the way, there were the following troubles in the conventional fuel cell power plant which purifies by the water treating unit as mentioned above, using a city water as make up water.

[0022] Said water treating unit has the short life of ion exchange resin, and its maintenance costs including exchange of ion exchange resin are high. Since the rate of occupying to the total cost including the running cost of the fuel cell power plant of these costs is large, the adoption or rejection of a fuel cell power plant is hit, and it has become one of the necks in the viewpoint of economical efficiency.

[0023] Moreover, since said water treating unit does not have supply of heat out of a system during operation of a fuel cell, in the cold district, it has fear of freezing and has also become one factor in which the cure against anti-freeze also increases whole cost.

[0024] Originally, generation-of-electrical-energy generation water arises, and combustion generation water arises with combustion also in a fuel reforming machine, as mentioned above, these generation water is collected, the direction of recycled water is superior in the electrochemical reaction of a fuel cell as compared with the feedwater, then the required feedwater for reforming steam generating, and recycled water is made to usually overflow from a recycled water tank. Furthermore, since the amount of phosphoric acid does not exist in recycled water like a phosphoric acid fuel cell in a polymer electrolyte fuel cell a top with few impurities compared with the usual tap water, said recycled water is **** in which self-sustaining is possible, even if there is no water treating unit.

[0025] When outside air temperature becomes [a place] 35 degrees C or more in a summer, the situation where the engine performance of the recycled water condensator 34 falls, cannot condense air and the steam in gas, but the engine performance of a direct contact type heat exchanger falls, and recycled water runs short arises. Moreover, in long duration operation, even if outside air temperature is 35 degrees C or less, when slime etc. adheres to packed beds, such as the above-mentioned Raschig ring, and the nozzle of a sprinkler system is got blocked in them by a water scale etc., the situation where the engine performance of a direct contact type heat exchanger falls, and recycled water runs short arises. In this case, since a city water with low purity will be supplied, the water treating unit is indispensable.

[0026] Having been made in view of the above-mentioned trouble, and the technical problem of this invention always making possible water self-sustaining by recycled water, and supplying water with purity high without a water treating unit making it possible also in the short-time special case in which self-sustaining is impossible, and offering a cheap fuel cell power plant and its operating method has this invention.

[0027]

[Means for Solving the Problem] In order to solve the above-mentioned technical problem, it sets to this invention. The fuel cell which generates the electrical and electric equipment based on electrochemical reaction with the air as the fuel gas obtained by carrying out steam reforming of the hydrocarbon system Hara fuel gas, and oxidizer gas, In the fuel cell power plant which has a fuel reforming system device, the cooling-water-system device of a fuel cell, and the recycled water system device that collects the water in the exhaust of a fuel cell, and the combustion gas of a fuel reforming machine Said recycled water system device should be equipped with a recycled water tank, the sprinkler system prepared in the upper part in this recycled water tank, the recycled water condensator, the level gage which detects the oil level in a recycled water tank, and the purified water supply container which supplies purified water based on the liquid level measurement result of this level gage (invention of claim 1).

[0028] According to invention of above-mentioned claim 1, at the time of steady operation, water self-sustaining by recycled water is performed without supplying purified water, when the impossible situation of water self-sustaining becomes clear, purified water can be supplied from a purified water supply container, and operation can be

continued by the liquid level measurement result, so that it may mention later. As a purified water supply container, the cheap purified water bottle (it is 98 yen with a 350ml bottle) marketed in the chemist's shop etc. can be used. Moreover, water can also be stored in the purified water purchased on the tank for purified water supply.

[0029] As an embodiment of invention of said claim 1, following claim 2 thru/or invention of 3 are desirable. Moreover, as an operating method, following claim 4 thru/or invention of 5 are desirable. It is as having given profile explanation in the publication of the term of said Prior art etc. about above-mentioned claim 2 thru/or the operation effectiveness of invention of five. In addition, details are supplemented and explained in the example mentioned later.

[0030] That is, in said fuel cell power plant according to claim 1, said recycled water tank should be equipped with packed beds, such as Raschig ring as a cooling water direct contact process condenser, between the sprinkler systems, exhaust inlets, and combustion-gas inlets in the upper part in a recycled water tank (invention of claim 2).

[0031] Moreover, said recycled water tank should be equipped with the overflow pipe for discharging superfluous recycled water in said fuel cell power plant according to claim 1 or 2 (invention of claim 3).

[0032] furthermore, at the time of steady operation whose liquid level measurement result of said level gage are the operating method of said fuel cell power plant according to claim 1 to 3, and shows a high order from predetermined level (L) When water self-sustaining by recycled water is performed and said liquid level measurement result reaches predetermined level (L), without supplying purified water, purified water is supplied from a purified water supply container to predetermined level (H), and operation is continued (invention of claim 4).

[0033] When said water self-sustaining becomes impossible by a certain cause and the liquid level measurement result of said level gage reaches the predetermined maximum minimum level (LL) in said operating method according to claim 4 further again, supply of purified water is stopped and operation of a fuel cell power plant is suspended (invention of claim 5).

[0034]

[Embodiment of the Invention] Based on a drawing, the example of this invention is described below.

[0035] Drawing 1 is the schematic diagram showing the example in connection with this invention, gives the same number to the member which has the same function as drawing 2, and omits explanation. Moreover, in drawing 1, among the system networks of explanation shown in drawing 2 for convenience, it carries out a current update in part, using the recycled water system device 30 as a subject, and is shown, and other networks, such as a fuel cell, a fuel reforming system device, and a cell cooling water system, omit, and are shown.

[0036] The recycled water tank [in / in the difference between drawing 1 and drawing 2 / drawing 1] 31 is a point equipped with the packed bed 36 prepared between the sprinkler system 32, the exhaust inlet, and the combustion-gas inlet, a level gage 37, the purified water bottle 38, the closing motion control valve 39 for performing supply control of purified water based on the liquid level measurement result of this level gage, and the overflow pipe 40 for discharging superfluous recycled water.

[0037] Said level gage 37 is outputted to the control unit which does not illustrate the liquid level of the three-stage of H, L, and LL which are shown in drawing 1, and it is constituted so that supply of purified water, a halt of equipment, etc. which mention later may be controlled. That is, water self-sustaining by recycled water is performed, without making the closing motion control valve 39 close, and supplying purified water from

predetermined level (L) by the liquid level measurement result of a level gage 37, as mentioned above, at the time of steady operation which shows a high order. Moreover, when said liquid level measurement result reaches predetermined level (L), the closing motion control valve 39 is made open, purified water is supplied from the purified water bottle 38 to predetermined level (H), and operation is continued.

[0038] Furthermore, when said water self-sustaining becomes impossible by a certain cause and the liquid level measurement result of a level gage 37 reaches the predetermined maximum minimum level (LL), the closing motion control valve 39 stops supply of purified water as close, and suspends operation of a fuel cell power plant.

[0039] By the way, when water self-sustaining by recycled water is continued for a long period of time, since the water in a system is not purified, it is possible [it / with the ion exchange resin in a water treating unit] that the conductivity of the water in a system increases gradually. When a follow-up survey was conducted about the example about this point, it became clear after about 48-hour progress that a saturation state (saturated with cm less than in about 10microS /) was reached. It follows, for example, water self-sustaining by recycled water can be continued satisfactory for a long period of time by management of pure water permuting the water in the after [operation] (once in about five years) system of 40,000 hours.

[0040]

[Effect of the Invention] The fuel cell which generates the electrical and electric equipment based on electrochemical reaction with the air as the fuel gas obtained by carrying out steam reforming of the hydrocarbon system Hara fuel gas, and oxidizer gas according to this invention the above-mentioned passage, In the fuel cell power plant which has a fuel reforming system device, the cooling-water-system device of a fuel cell, and the recycled water system device that collects the water in the exhaust of a fuel cell, and the combustion gas of a fuel reforming machine The sprinkler system which prepared said recycled water system device in a recycled water tank and the upper part in this recycled water tank, Since it shall have a recycled water condensator, the level gage which detects the oil level in a recycled water tank, and the purified water supply container which supplies purified water based on the liquid level measurement result of this level gage Water self-sustaining by recycled water can always be made possible, and supplying water with purity high without a water treating unit can make it possible also in the short-time special case in which self-sustaining is impossible, and a cheap fuel cell power plant and its operating method can be offered.

[Translation done.]

* NOTICES *

JPO and NCIP are not responsible for any damages caused by the use of this translation.

- 1.This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.*** shows the word which can not be translated.
- 3.In the drawings, any words are not translated.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the schematic diagram of a recycled water system device to the Lord in connection with the example of the fuel cell power plant of this invention.

[Drawing 2] The schematic diagram showing an example of the conventional fuel cell power plant

[Description of Notations]

10: A fuel cell, 20:reforming system device, 30:recycled water system device, 31:recycled water tank, 32:sprinkler system, 33:recycled water pump, 34:recycled water condensator, 36:packed bed, 37:level gage, 38:purified water bottle, 39:closing motion control valve, 40:overflow pipe, 50 : cooling-water-system device.

[Translation done.]

[Translation done.]